Restoration of *C. mydas* in the Caribbean: exploring ecosystem impacts with Ecopath with Ecosim

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Outline

- Recovery goals
- Carrying capacity for the Caribbean
- *Chelonia mydas*' ecological 'role' in seagrass systems
- Introduction to Ecopath with Ecosim
- Model description
- Preliminary results
- Conclusions

Recovery goals

- Recent upwards trends of green turtle nesting at Tortuguero (Bjorndal et al. 1999)
- What baseline should we use?
  - IUCN ‘s 10 yrs or 3 generations before present (1865 to 1895 based on latter)
  - earliest estimates of past sea turtle populations
- Baselines versus recovery goals

Seagrass distribution in the Caribbean

- Original data 89,998 sq km
- New data obtained for the US & British Virgin Islands, Guadeloupe, Colombia, Puerto Rico and Florida
- May – June 2006: Landsat mapping

Polygon	Area (km2)
WCMC	66,871
USVI	83.65
BVI	39.94
Puerto Rico	624.78
Florida	9,260.55
Colombia	0.43
Guadeloupe	166.9
TOTAL	**77,047**

Estimates of carrying capacity

Reference	*# of turtles in Caribbean*
Jackson (1997)	33 - 660 million
Bjorndal (2000)	16 - 586 million
Moran & Bjorndal (2005)	16 - 586 million 207- 495 million
Wabnitz (unpubl.)*	19 – 684 million

- Estimates are based on differing rates of intake, *T. testudinum* productivity, and a turtle size of 50kg.
- Assumes uniformly dense seagrass beds

* based on revised seagrass distribution

Ecological role

- Recovery goal: abundance at which turtles fulfill their ecological roles
- Focus shift from single species recovery strategy to ecosystem function
- Reconstruction and quantification of role of turtles in pristine environment
  - lack of data to create such a system
- Instead: Start with system now and add turtles

Ecopath with Ecosim

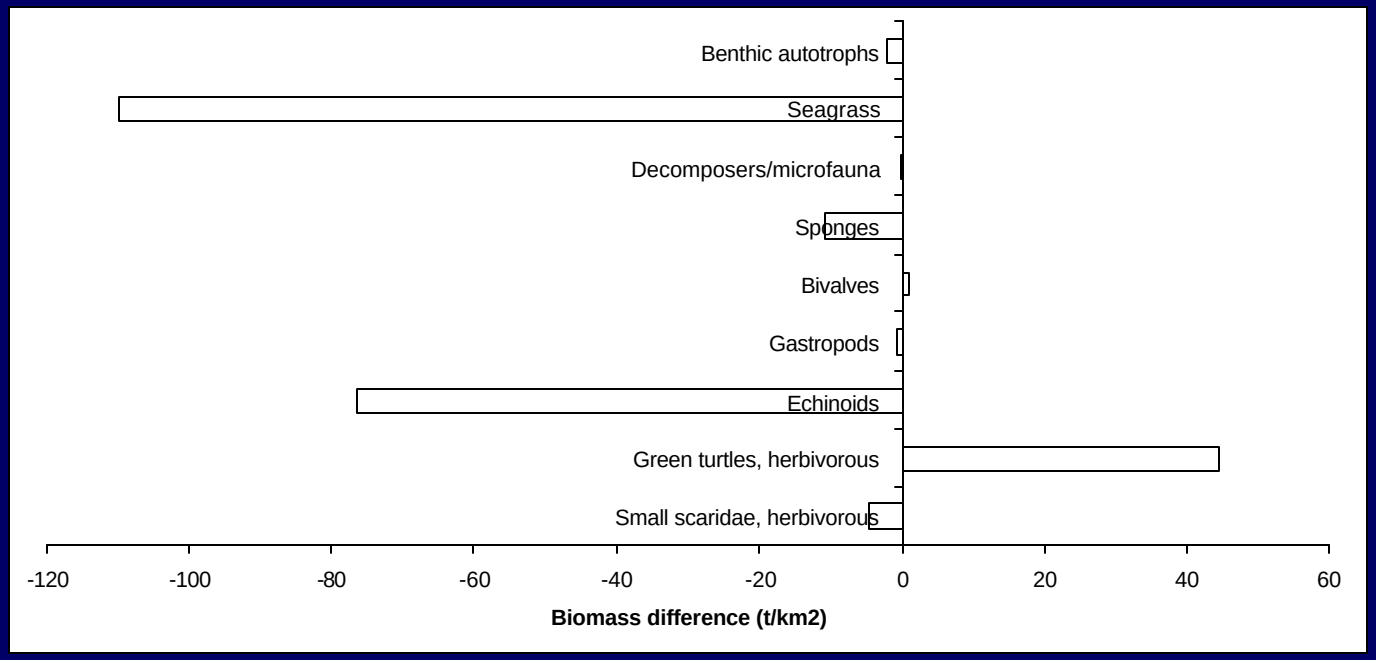
- Tool designed to allow for the construction and parametrisation of mass-balance trophic models
- **Ecopath** – quantitative description of biomass flows in the system
- static mass balance snapshot of system; overview of feeding interactions in ecosystem and resources it contains
- **Ecosim** – time dynamic simulation - e.g effects of fishing pressure; nutrient loading; biomass accumulation of species group

The model

- Framework based on the coral reef ecosystem model developed by Silvia Opitz (1996)
- Puerto Rico/Virgin Islands system
- Assumptions:
  - No fishing
  - Epiphytes contained within ‘benthic autotrophs’ pool
  - Present state = high seagrass biomass & low turtle abundance

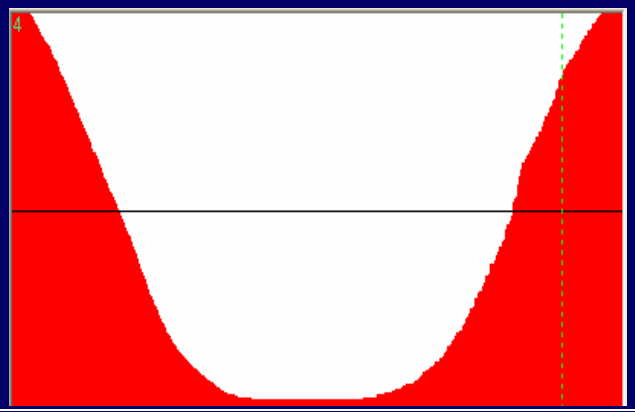
Preliminary results

- Only trophic interactions

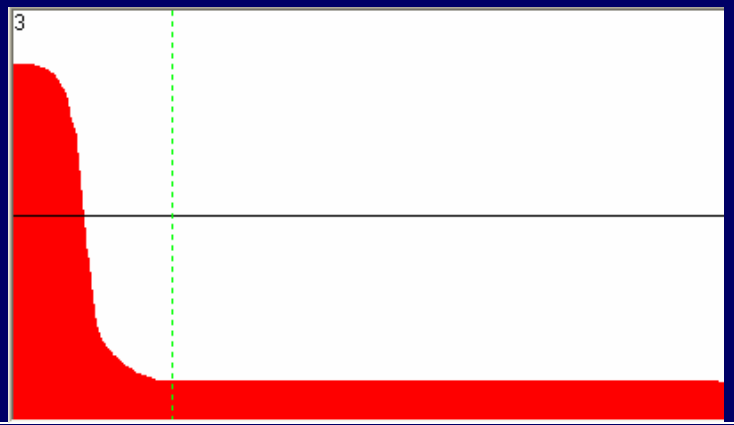


Results
Mediation functions

- Add physical interaction, i.e. mediation functions
- Compensatory growth response of seagrass (Moran & Bjorndal 2005) hard wired into EwE
- Refuge role (Heck & Orth 1980; Zieman 1982)



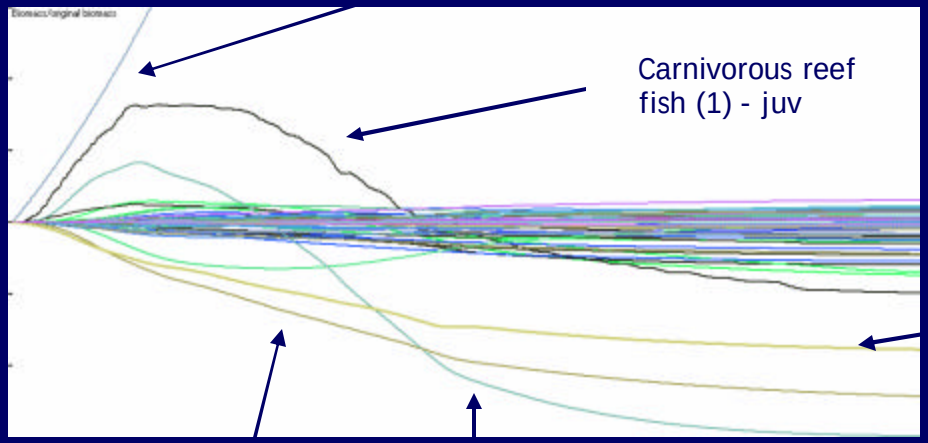
Small fish

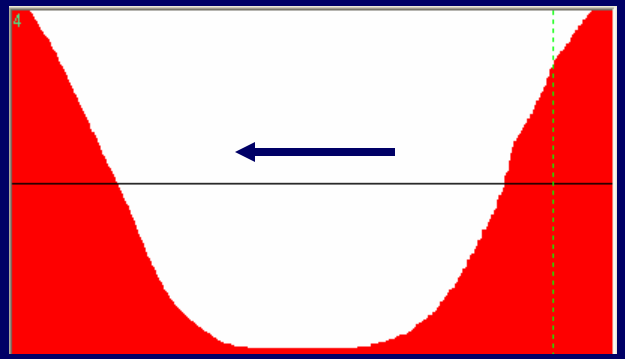


Small fish prey

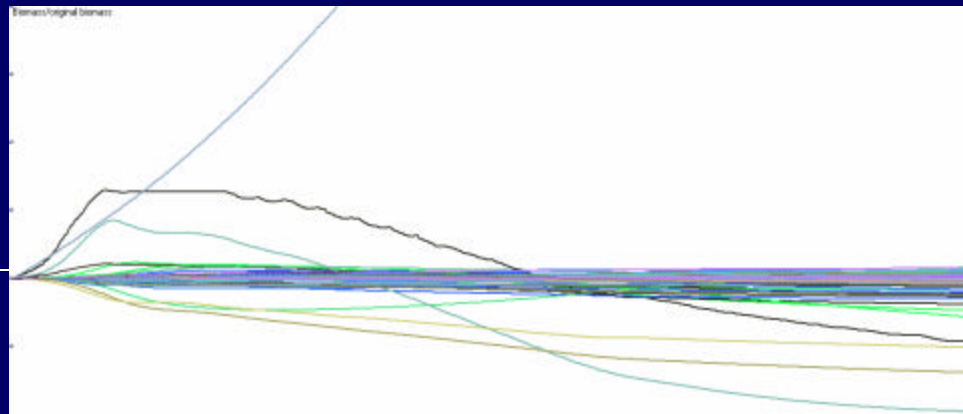
Results

- Mediation F(x): Refuge only



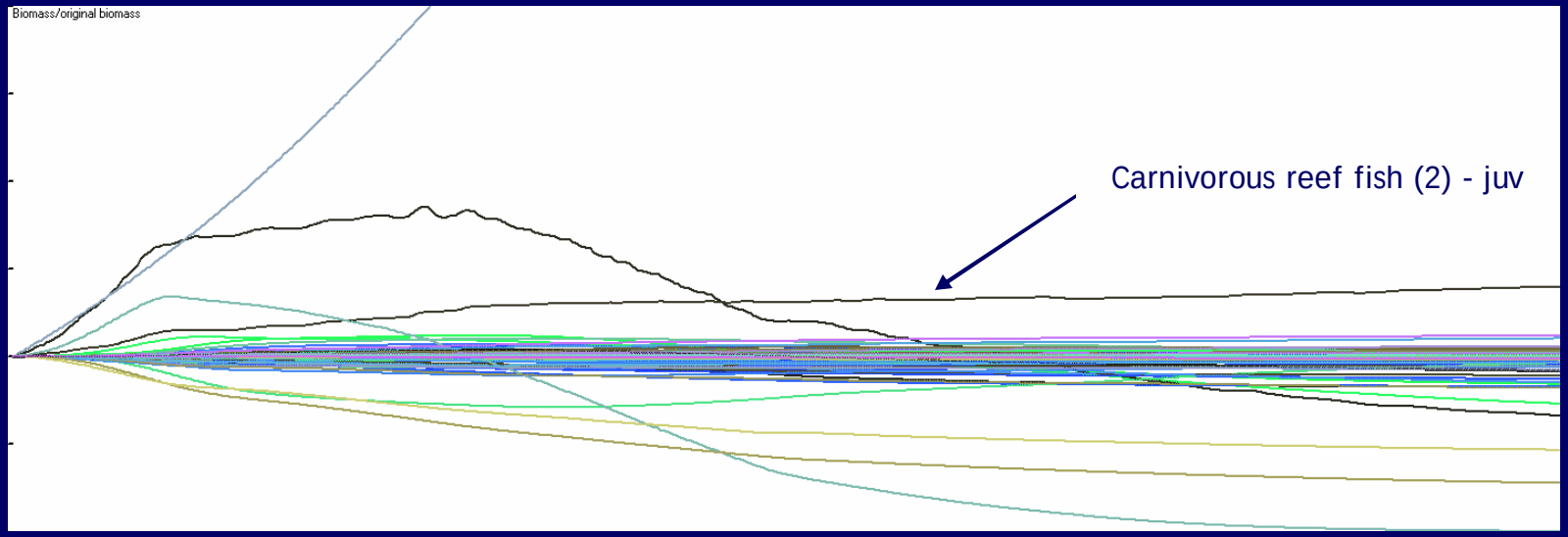


Seagrass



Results

- Refuge and effect on their prey
- Strength of response <> shape of mediation function



Limitations

- Lack of spatial dimensionality
- Impact of abiotic factors (e.g. changes in oxygen concentration and/or salinity) are not considered

Future work

- Refine trophic interactions, as well as estimates of P/B and B
- Include epiphytes as a separate group
- Role of mesograzers on epiphytes (Hughes et al. 2004; Hays 2005)
- Include nutrient dynamics

Conclusions

- Model captures the ecosystem dynamics when managing specifically for a protected species (i.e. biomass increase)
- Model highlights current gaps in understanding of processes at the system level
  - Refuge role afforded by ungrazed and grazed seagrass
  - Estimate of grazing rates

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